Center Independent Research & Development: GSFC IRAD

Complementary Bayesian and mAchine Learning Toolbox (CoBALT)

Completed Technology Project (2017 - 2018)

Project Introduction

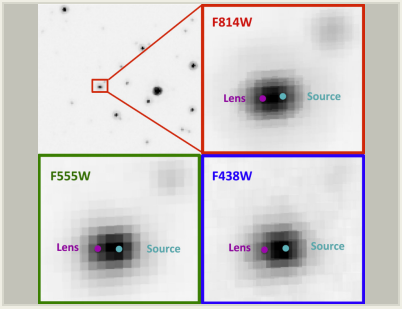
CoBALT seeks to develop a strategic partnership with Japan for the PRIME telescope in South Africa and the MOA II telescope in New Zealand for the purpose of advancing technologies for space application. Specifically, CoBALT will develop a new approach to the automatic detection and characterization of gravitational microlensing events using machine learning and Bayesian modeling. This technique will permit rapid identification of promising planetary events for follow-up by ground and space-based observatories and is broadly useful for any time-variable phenomena.

Anticipated Benefits

CoBALT provides a systematic way to autonomously determine the likelihood that a transient from this down-selected set is a genuine microlensing event and, once detected, to combine information from disparate data sets, together with background knowledge in the form of prior expectations to facilitate the estimation of parameters for a microlensing event as well as an ensemble of events. This will include distances, magnitude, binarity, temperature, extinction, and proper motion of source and lens, observatory characteristics, and lens system geometry. We will specify the likelihood function by constructing a forward model for the source stellar spectrum, an interstellar dust extinction law, and the band-pass spectrum and sensitivity of the observing instruments. The priors would include a physical model for the source and lens color and magnitude, assumptions about source and lens distances and dust fields, and an array of

possible lens system geometries. Our ultimate objective is to move beyond analysis at the level of individual events toward Bayesian characterization of higher-level parameters including approximate 3D modeling of the dust extinction — crucial for lens mass determination, characterization of the stellar population in the observation field, and lens geometry determination, characterization and quantification.

The proposed research is directly applicable to a generalized approach to time-domain photometry that may be used in a broad range of research. It draws from the theoretical and modeling expertise that Co-Is Schnittman and Baker have developed over years of gravitational-wave data analysis studies, as well as the observational experience that PI Barry has with microlensing data. By investing a small number of FTEs now, we will be able to develop and demonstrate capabilities critical for winning future ROSES proposals such as Astrophysics Theory, Astrophysics Data Analysis, Habitable Worlds, and Emerging Worlds. As demonstrated by the broad variety of applications described above, microlensing is inherently a multi-disciplinary subject, and the approach we propose is particularly well suited for the diverse facets of the field.



Proof of the planetary provenance of the microlensing event OGLE-2005-BLG-169

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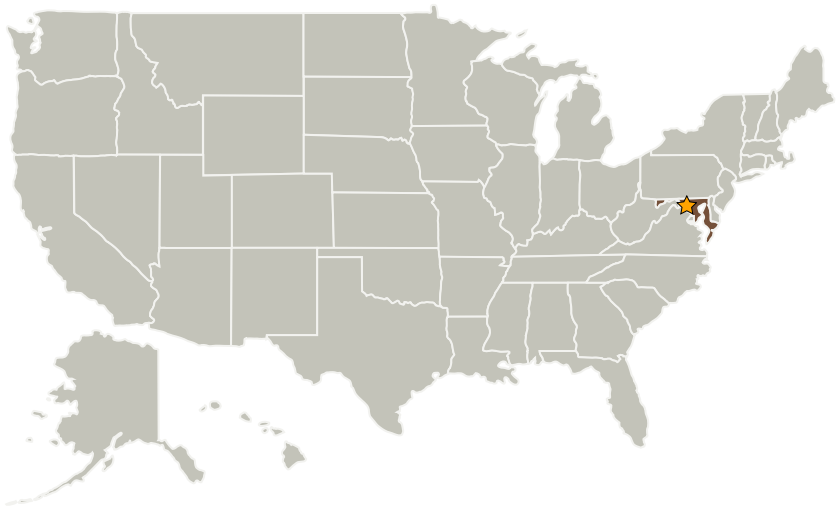
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
★Goddard Space Flight Center(GSFC)	Lead Organization	NASA Center	Greenbelt, Maryland

Primary U.S. Work Locations
Maryland

Organizational Responsibility

Responsible Mission Directorate:

Mission Support Directorate (MSD)

Lead Center / Facility:

Goddard Space Flight Center (GSFC)

Responsible Program:

Center Independent Research & Development: GSFC IRAD

Project Management

Program Manager:

Peter M Hughes

Project Managers:

Megan E Eckart
Timothy D Beach

Principal Investigator:

Richard K Barry

Co-Investigators:

Jeremy D Schnittman
John G Baker

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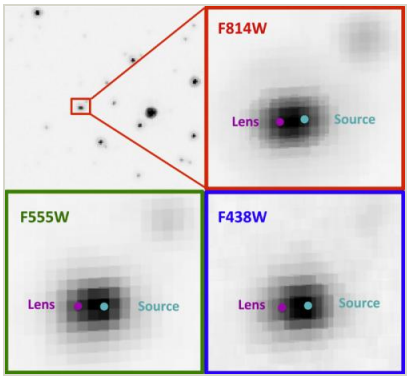
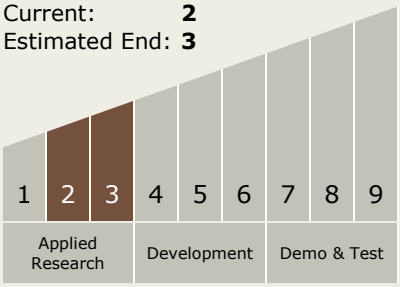
Images



OGLE-2005-BLG-169
Proof of the planetary provenance of the microlensing event OGLE-2005-BLG-169
(https://techport.nasa.gov/image/28488)

Technology Maturity (TRL)

Start: **2**
Current: **2**
Estimated End: **3**



Technology Areas

Primary:

- TX10 Autonomous Systems
  - TX10.1 Situational and Self Awareness
    - TX10.1.5 Event and Trend Identification

Target Destination

Outside the Solar System

Supported Mission Type

Planned Mission (Pull)